p468 Q87
rms - root mean square

square all the values, take the average and square root the average

$v_1 = 2$, $v_2 = 4$

$$\frac{4+16}{2} = 10 \qquad \sqrt{10} = 3.16 \text{ rms}$$

$$\frac{2+4}{2} = 3 \text{ mean}$$

$$\rho = \frac{M}{V} \qquad \sout{P = \frac{F}{A}} \qquad \bar{E}_k = \frac{3}{2}k_B T$$

$$\bar{E}_k = \frac{1}{2}m(v_{rms})^2$$

$$PV = nRT$$

$$P\frac{M}{\rho} = nRT = nR\frac{2E_k}{3k_B}$$

$$\frac{P\sout{M}}{\rho} = nR\frac{m\,v_{rms}^2}{3k_B}$$

$$\overline{\rho} \qquad \overline{3k_B}$$

$$V_{rms}^2 = \frac{3 k_B P}{\rho n R} \qquad k_B = \frac{R}{N_A}$$

$$V_{rms}^2 = \frac{3 P}{\rho n N_A}$$

$$V_{rms} = \sqrt{\frac{3 P}{\rho n N_A}}$$ one molecule

$$V_{rms} = \sqrt{\frac{3P}{\rho}}$$

$$\frac{1}{2} m V_{rms}^2 = \overline{E}_k$$

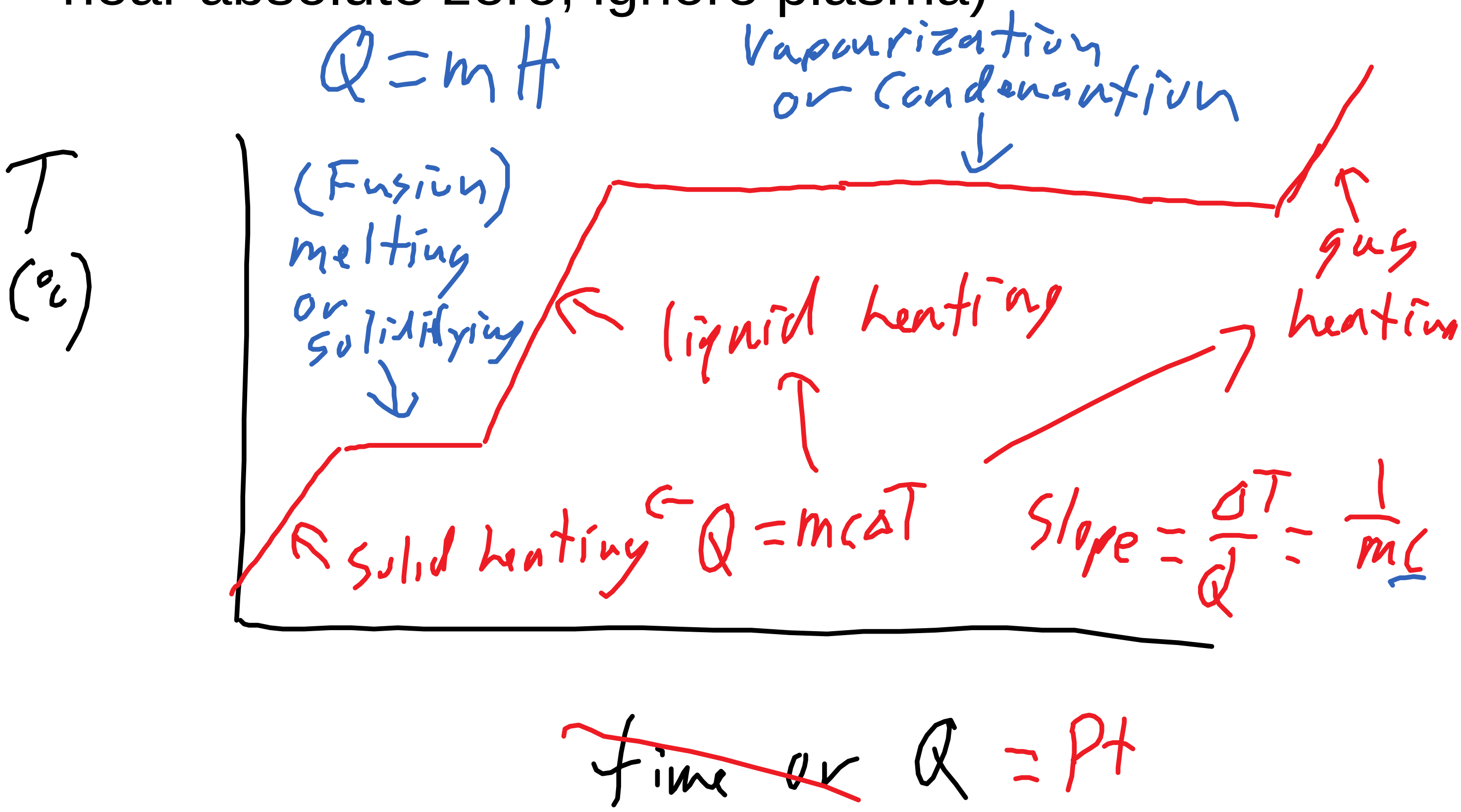
Watch out,
Book definition of Thermal energy is not the same

as IB

IB- internal energy, U is total kinetic and potential energy of all the particles making up an object. (book calls that thermal energy)

Heat (IB also calls this thermal energy) is the change in internal energy. $\Delta U = Q$

Heating curve of a substance:
(ignore Boze-Einstein condensate - state of matter near absolute zero, ignore plasma)



Sublimation - solid ⟺ gas

c is the specific heat capacity, constant for a material of the heat, in Joules, required to change

the temperature of 1kg of the material by 1ºC or 1K.

Sand has a specific heat capacity of about 500 J/kgºC
Water has a specific heat capacity of 4180 J/kgºC (water's is very big)
lead is only 130 J/kgº, very low

factors that influence c - the number of molecules/mass - the rotational energy - the intermolecular attraction - slightly influenced by temparature

Hecht p 477 table of specific heat capacities.

Heat capacity is the energy to change the temperature by 1K or 1ºC for a particular sample.

Table of heats of fusion and vapourization p481

water - fusion is 3.34×10^5 J/kg vapour is 2.26×10^6 J/kg

lead melts at 327.4ºC H_f=22.9 kJ/kg H_v=871kJ/kg at 1620ºC
eg.
A 90.0 g lead bullet is at room temperature, 20.0ºC. How much energy is required to
a) heat the bullet to the melting point, 327.4ºC?
Q=mcΔT= 0.090kg 130J/kg (327.4ºC-20.0ºC)
0.09x130x307.4=3 596.58 = 3.60 kJ

$Q = mc\Delta T = 0.090kg\ 130J/kg\ (327.4^oC - 20.0^oC)$
$0.09 \times 130 \times 307.4 = 3{,}596.58 = $ 3.60 kJ

b) melt the bullet
$Q = mH_f = 0.090\ kg \times 22.9kJ/kg$
$0.09 \times 22.9 = 2.061 = $ 2.06kJ

c) heat the molten lead from 327.4ºC to 1620ºC
d) vapourize the bullet
e) how fast would you have to shoot the bullet for it to vapourize on collision (state assumptions)
f) draw a scale heating curve for the lead bullet (graph paper - by hand not computer)

- assume the heat capacity of liquid, solid and vapourized lead is the same, 130 J/kg

p498-502
17, 21, 23, 51, 61, 69, 81

Lab next class - specific heat capacity
- formal lab - p34 on online lab manual